

***Advanced Exponential and Multirate Integrators for Multiple  
Time Scale Problems***

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Many science and engineering problems involve multiple physical processes, with complex interactions that result in dynamics spanning a wide range of time scales. This presents significant challenges for real-time simulation of these multiphysics problems. A prominent example is the existence of vastly differing time scales in atmospheric phenomena, ranging from a relatively slow advection to very fast gravity waves, which poses significant difficulties for real-time simulation of weather and long-term climate predictions. Developing fast and accurate time integration methods is thus crucial for a wide range of applications that rely on simulations of complex multiphysics systems.

In this talk, we will present our recent advancements in constructing, analyzing, and implementing new exponential and multirate time integration methods. These methods enhance both accuracy and efficiency in computational simulations of large-scale, multiple time scale problems. We will also showcase their performance through numerical experiments across various applications, including visual computing, numerical weather prediction, and computational biology.

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